THURSDAY, AUGUST 16, 1900.

A STANDARD TEXT-BOOK OF PHYSICS.

Müller-Pouillet's Lehrbuch der Physik und Meteorologie. Neunte umgearbeitete und vermehrte Auflage von Dr. Leopold Pfaundler. In drei Bänden. Erster Band, Mechanik, Akustik. Pp. xxi + 888 (1886). Zweiter Band, unter Mitwirkung des Dr. Otto Lummer, Erste Abtheilung, Optik. Pp. xx + 1192 (1894–1897). Zweite Abtheilung, Wärme. Pp. xiv + 768 (1898). Dritter Band, Elektrischen Erscheinengen. Pp. xvi + 1062 (1888–1890). (Braunschweig: Friedrich Vieweg und Sohn.)

THE appearance of the second part of the second volume of this work marks the completion of the ninth edition of an important treatise on experimental physics which has for many years been widely used in Germany. The importance of the work lies in the fact that it aims at giving a full description of physical apparatus and experimental methods, no attempt being made to expound mathematical theories, and none but the most elementary mathematics being employed or assumed as one of the reader's acquirements.

Herein the work differs from most of our English text-books of physics, in which the tendency has latterly been to combine a certain amount of mathematical theory with short accounts of experiments in illustration of the theory, both the mathematical and experimental portions being of necessity very incomplete. This tendency, probably necessitated by our examination system, will, as long as it continues, prevent our having in English such complete works on experimental physics as that now before us.

Any work on physics, however, in several volumes produced at different times, must, when completed, present some lack of uniformity among its parts, especially if the part dealing with that branch of the subject which varies most rapidly is not produced last. This is the case in the present instance. The volume on magnetism and electricity was published some ten or twelve years ago, several years before the appearance of the volumes on light and heat. The reason given is that, on account of the rapid advance made in electricity, the volume dealing with this branch in the previous edition appeared much more out-of-date than the other volumes, and therefore had more need of revision. For the same reason, on now reviewing the whole of the present edition, one cannot help being struck with the fact that the volume dealing with electricity and magnetism far less adequately represents the present state of the subject in this branch than do the other volumes in their own regions.

In the first volume of the present edition, dealing with mechanics and sound, after an introductory chapter on fundamental notions and a short discussion of uniform and uniformly accelerated motion of a point in a straight line, the subject of mass and force is immediately taken up, further treatment of kinematics being postponed to a later stage. It seems to the writer to be preferable, especially in an elementary book on the subject, to deal more fully with kinematics before going on to dynamics proper. The student should first become well acquainted with the notions of velocity, acceleration, their composition and resolution, and should give special attention to cases in which the acceleration is not in the same direction as the velocity. In this way he is enabled to acquire a much clearer idea about acceleration as a quantity with a direction of its own, and is therefore much better prepared to make the transition from his previous vague notion of force to the more accurate dynamical meaning of the term.

The subject of mass and its measurement is discussed at some length, and in a very instructive manner. The action of a force in producing acceleration in a body is finally adopted as the basis of the dynamical measurement of mass. This system involves the definition of force. A definition of mass (due to Mach) independent of the definition of force is referred to in a footnote on p. 85, viz.: bodies which (by gravitation) produce equal but opposite accelerations in each other are said to have equal masses. This includes the definition of the ratio of the masses of two bodies as the ratio of the accelerations which they produce in each other, and when a unit of mass is chosen, the mass of any other body is measured by the acceleration given to the unit divided by the acceleration experienced by the body itself.

The phraseology is sometimes not as accurate as one could wish; thus on p. 92 we find the expression "an acceleration of one metre," and in the following sentence, "a velocity of one metre"; and again, the kilogramme is stated to be both the unit of mass and the gravitational unit of force. Although explanations follow, it must lead to some confusion in the mind of a beginner to find that a kilogramme means sometimes a mass and sometimes a force. It is of the greatest importance in an exposition of the principles of dynamics that one meaning only should be attached to every technical term. A similar confusion arises in connection with the term "weight," about which there is a lengthy discussion on pp. 96–99. The difficulty might have been much diminished by reserving the word kilogramme to mean a mass and weight to mean a force—viz. the resultant force acting on a body falling freely near the earth. The common use of the terms should be explained afterwards.

On pp. 326–333 a short account is given of the behaviour of spinning tops and gyroscopes, with a general explanation of the couples called into play by a deflection of the axis of rotation. The "drift" of a shell fired by a cannon is ascribed mainly to gyrostatic action. The constantly increasing angle between the axis of rotation and the direction of motion causes the air in front of the shell to exert a force tending generally to raise the head of the shell with respect to the centre of mass; this produces a deflection of the point of the shell to the right, and the increased pressure thus introduced on the left side causes a deflection to the right. It is possible that, with a shell of suitable shape, the pressure of the air would tend to raise the rear end, and the gyrostatic deflection would in this case be to the left. As is remarked in a footnote, however, the greater friction on the under side of the shell probably plays an important part, and this always causes a drift to the right.

In Chapter v. a good elementary account of the laws of capillarity is given. On p. 444 Quincke's falling drop method of measuring surface tensions is described, the weight of the drop being stated to be equal to the product of the surface tension and the circumference of the line of contact. Lord Rayleigh has shown that this is not correct even if the liquid motion in the drop at the moment of separation be neglected ; the excess of pressure in the drop corresponding to the curvature of the surface (supposed cylindrical near the plane of contact) has the effect of diminishing the size of the drop to one-half the value stated, and this result agrees more closely with experiment.

The second part of the volume, on sound, resembles in its general mode of treatment most other elementary text-books on the subject. The general nature of wave-motion is made quite clear by numerous diagrams of wave-curves and wave-machines. The deduction given on p. 638 of the expression $\sqrt{E/D}$ for the velocity of propagation of sound-waves is not satisfactory, since it involves the tacit assumption that the whole energy is half potential and half kinetic.

In connection with the experimental measurement of the velocity of sound in water in tubes, referred to on p. 643, the influence of the walls and Kundt's measurements in tubes with walls of different thicknesses should have been mentioned, and in the description of the resonance tube experiment, no method is given for eliminating the end correction.

The last chapter contains an interesting account of the researches of von Helmholtz and others on the vibrations of violin strings, combination tones, analysis of sounds, and the theory of consonance and dissonance.

In the second volume (light and heat) the author is assisted by Dr. Lummer, who, we are told in the preface, is chiefly responsible for the part dealing with optical systems and the theory of optical instruments. This part of the work has been largely re-written for the present edition, and brought well into line with the modern views on image-formation founded by Abbe.

As is the case in doing most things, there are two ways of writing a book on geometrical optics. The first, until recently the usual, method is to begin with very special cases, such as thin lenses, and proceed by degrees to the more general cases of thick lenses and systems of lenses.

The other, and more modern, method is to begin with the general case of a point-point correspondence between two portions of space, of such a kind that to a pencil of rectilinear rays passing through a point in one region corresponds a pencil of rectilinear rays passing through a point (the image) in the other region ; then to introduce the special cases of image-formation by reflecting or refracting surfaces and centred systems, including lenses. The two methods thus proceed on opposite lines.

The latter method has been perfected by Abbe, and is the one adopted by Czapski and, though necessarily in a more elementary and restricted manner, in the present work.

After two chapters dealing with the nature of light, photometry, refraction and reflection at plane surfaces, Chapter iii. treats of the formation of images by refraction at a single spherical surface ; then the general case of any number of spherical surfaces separating different media, with their centres in a straight line ; and, finally, two co-axial centred systems, with the special case of a "telescopic" system in which the "interval" is zero. The lens is regarded as two centred systems, each consisting of a single spherical surface.

Chapter xii. is devoted to the theory and use of "stops,' the calculation of magnifying power and brightness of images in centred systems, and, finally, the laws of formation of images of illuminated objects, as in the ordinary use of the microscope. Here purely geometrical methods break down, and diffraction spectra play an all-important part. A highly interesting account follows o Abbe's theory of microscope images and its remarkable verification by the use of the diffraction plate, in which is shown how the similarity of image to object, as well as the resolving power of the instrument, depends upon the number of diffraction spectra whose rays enter the objective and take part in the final image-formation. How these principles are applied in the construction of microscope-objectives is set forth in the chapter on optical instruments, which also contains details of many of the latest improvements in optical instruments of all kinds.

The second part of vol. ii. (on heat) does not differ from the corresponding part of the previous edition so fundamentally as is the case with the part on optics ; but it is brought more nearly up-to-date by many additions, including the work of Olszewski and Linde on the liquefaction of gases, a chapter on thermochemistry, steam calorimeters, recent determinations of the specific heat of water at various temperatures and of the mechanical equivalent of heat. No reference is made, however, to recent improvements in the choice of a unit of heat.

Thermodynamics does not receive very much attention, few applications being mentioned beyond Kelvin's definition of absolute temperature, and a calculation of the change of melting point produced by pressure. Some details are given, however, of the parts and action of steam, air, and gas engines.

A short chapter on meteorology, dealing with climatic conditions and their changes, brings this volume to a close.

As to the third volume, it suffers, as was remarked before, in comparison with the other volumes from having been written several years ago. Still, it contains a large mass of useful information about electrical and electro-technical apparatus, much of which is not usually found in text-books on electricity and magnetism.

It is impossible, in the space at our disposal, to give more than a very rough sketch of a work which extends to close upon 4000 pages, and many excellent qualities of the work must for this reason remain unmentioned. One of the chief features is the large number (nearly 3000) of excellent illustrations, and, chiefly in the section on optics, some very beautiful coloured plates. Explanations are, as a rule, given very clearly, and often aided by numerical examples worked out. Further, on account of the very large number of experiments and forms of apparatus described, as well as the numerous references to original papers, the work is certain to prove useful, as it no doubt has already done, to students and teachers of physics.